

# Use of succulent bio-medicines to control COVID-19



Dr. Shibabrata Pattanayak

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to control COVID-19**

***By***

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**ISBN: 978-93-5407-265-9**

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Composed by: Ajit Kumar Bhakat

Printed by:

Calcutta Block & Print

Sikdar Bagan street

Kolkata – 700004, India

*Dedicated to:*

*The researchers agree with the novel  
concept of use of succulent parts of  
plants in healthcare*



## PREFACE

Use of succulent bio-medicines and other succulent bio-healthcare products can bring a dramatic change in initiation, progression as well as expression of symptoms of various diseases among individuals. Succulent parts of some effective medicinal plants in the form of paste or pressure extract can be covered by some digestible capsular materials of biological origin without addition of any synthetic chemical and may be used as preventive oral medicines against COVID-19. Plants having ethnomedicinal reports of having strong immunomodulation and antioxidation activities and plants having role in protection of respiratory organs may be selected for such use to strengthen the immunity power of the people to become refractory to the viral infections. Name of such medicinal plants with relevant parts and previous reports on their related activities, discussion of various steps related with preparation of a design for efficacy based study on the medicines and their dose determination; production, marketing and transport of these medicines up to the patient level; searching of answer of the questions raised against such herbal medicines and discussion of pros and cons of the use of such medicines are added in this book. A brief analysis of possible mechanism of actions of the succulent bio-medicines is also included in this book.

This book contains brief statements about many important physical, biological and biochemical procedures related with designing of the succulent bio-medicines. As it is not possible to include detail descriptions of all the procedures in the book, those are referred. Anybody can get them from the original books and articles.

I request all the readers of the book to put their efforts to create pressure on the research administrators and policy makers to accept the idea of use of succulent bio-medicines to prevent COVID-19, so that adoptive research for large scale production and use of these medicines can be initiated.

The sooner it will happen; the better will be the disease prevention scenario of the entire world.

Date: 16.05.2020

Thanking you,

**Dr. Shibabrata Pattanayak**  
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# USE OF SUCCULENT BIO-MEDICINES TO CONTROL COVID-19

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## **Chapter I**

### **COVID-19 pandemic and possible role of succulent bio-medicines in its control**

The pandemic caused by the COVID - 19 virus is forcing all the researchers of all the related fields to think over the problem seriously and to consider various ways to combat the situation. As no presently available antiviral allopathic medicine is found to be effective and no effective vaccine is also available, the virus becomes a great concern for the whole human civilization. Some unique characters of that virus made it very difficult to get rid of the problem following the conventional ways of research and medication.

As a part of searching of new avenues, stimulation of immunity of individuals against that virus by dilatory use of encapsulated paste or juice of parts of effective medicinal plants at succulent stage is proposed in this book along with analysis of relevant parameters like validation of reported efficacy, dose and toxicity study, production and transportation of these medicines throughout the globe and searching of possible mechanism of action of these bio-medicines. The succulent plant medicines may have other positive effects on health like inducing of some anti-virus protection mechanisms through some direct actions on the invading viruses, but study reports on such activity is scarce.

## **Chapter II**

### **Parameters of normal immunity of individuals and possible relation of modulation of immunity by the succulent bio-medicines with control of COVID-19 virus infection**

The immune system has evolved to identify and destroy pathogens while minimising damage to the host tissue. Immunity is intrinsic to life and an important tool in the fight for survival against pathogenic microorganisms. The human immune system can be divided into two major components: the innate immune system and the adaptive immune system [1,2].

#### **Innate or non-specific immunity**

The innate immune system acts as the first line of defence of the host against invasion of any physical, cellular or biochemical components inside the body [3]. This defence system comprises of different barrier functions of the body (as skin, gut etc.), cytokines, action of phagocytic cells, natural killer (NK) cells, gamma-delta (gd) T lymphocytes etc. [4]. So, it generally provides immediate protection against the invading pathogens as the primary barrier. In this system, the host cells bearing germline-encoded pattern recognition receptors recognize pathogens and then trigger a variety of mechanisms to eliminate pathogens [1,2].

#### **Adaptive or acquired immunity**

This system generally takes comparatively more time to develop but can confer specificity and long-lasting protection. It is different from the innate system as it works specifically, having an element of memory. It is found only in vertebrate animals. It can be divided into two parts, humoral immunity and cellular immunity [3]

Basically, two different types of lymphoid cells work in the whole system. These are named as T and B cells, which lead the ‘cellular’ and ‘humoral’ immunity, respectively. These cells are found in the circulating blood as well as in peripheral lymphoid tissues [4].

### **Humoral immunity**

This system mainly deals with antibody production and destruction of extracellular micro-organisms [3].

The B lymphocytes are converted to the antibody producing plasma cells after getting stimulation by antigen. In this work, T lymphocytes, mainly the T helper cells assist the B lymphocytes.

The Plasma cells can secrete different immunoglobins (Ig) (antibodies) afterwards. As per the specific conditions, Ig M, Ig G, Ig A, Ig D and Ig E are secreted to perform their respective functions. Generally, the specific antibodies bind with specific antigens which leads to inactivation and destruction of such antigens by the phagocytic cells like macrophages [5].

### **Cellular immunity**

The two types of lymphocyte cells are involved in this system and they basically perform two important functions - killing of virus infected cells and killing of tumour cells. Cytotoxic T cells and Killer T cells routinely perform their works, respectively [3]. Recognition of the antigen on the targeted cell surface by the T cells of respective subpopulation leads to proliferation of these cells and then infiltration of these cells at the site of action to perform their duty [5].

These two systems are having various effects, all of which are dependent on many factors. They perform together and having some sorts of interrelations among them. The genetic predisposition of an individual predisposes different effects related with function of the parameters of the whole system which are triggered by other factors, mainly environmental and lifestyle related factors before their expression [1,2,6].

### **Role of non-specific immunity against infection of COVID-19 virus.**

As per the available reports, the virus causing pandemic (SARS-COVID-19 virus) infection is having some unique characters.

a) In many countries, it is found that almost 80% of the persons catch the infection of that virus and found with virus in their mucous membrane, but do not show any symptom of the disease. They are considered as silent carrier and blamed for spreading of the virus to other persons [7].

b) It is generally found that the persons recovered from any viral infection are having sufficient antibody against the virus inside their body and so they are resistant to that virus or that particular strain of virus (if there is any strain variation) for a period of time. But it cannot be said for the current COVID-19 virus. There is no evidence to claim that patients recovered from COVID-19 infection are protected from the second time infection [8].

### **Immunomodulation by succulent bio-medicines – an alternative to vaccination**

If we can think the subject in another way, it can be said that persons having sufficient individual non-specific immunity can stay away from the disease even after getting sufficient exposure to the COVID-19 virus. If the activated immunity of a large number of individuals can protect them from catching infection or if it can assist in reduction of severity of the disease symptoms of the patients, it will be a boon to us to control the pandemic COVID-19.

So, it can be said that if non-specific immunity of most of the individuals of a society can be increased up to the level of non-picking of infection and reduction of expression of disease symptoms, there will be a little chance of spread of that virus in the society. This may lead to prevention of the disease. The succulent medicinal herbs having strong immunomodulation power thus may act as alternative of an effective vaccine as well as a medicine without any side effects.

### **Boosting of non-specific immunity to prevent viral infections by dilatory use of succulent herbs**

As per available reports, many plant parts are either in use among some small communities or can be used efficiently as a stimulator of non-specific immunity as well as for their curative properties to get rid of the diseases of infective origin [9,6]. The plants which can be used at succulent stage without much research for the related purposes are shown in the Table 1. As many of these are used as some common spices as well as many people use these succulent bio-medicines regularly without any problem, these may be considered as more or less non-toxic to our health at the therapeutic doses. The doses used for such medicines are available only for some medicines, so this point is omitted in the list. With some basic level study, the effective doses of such bio-medicines may be determined as per standard protocols [10,11,12].

Some other medicinal plants are having report of use at purposes similar with altering of body immunity of individuals, prevention of diseases by their anti-microbial actions etc. These are also suggestive for use for prevention and/or control viral infections like COVID-19. But these plants require some more study, as these are not taken generally by the people at succulent state. These are listed in Table 2.

The in-patient trial or trial on laboratory animals may be performed for validation of the efficacy of all such bio-medicines before determining the therapeutic and toxic doses etc. following the standard protocols [10,11,12].

## **Chapter III**

### **Issues related with effective use of succulent bio-medicines to control viral infections**

#### **Validation, quality and safety issues of Herbal medicines – the constrains and possible solutions**

A possible holistic approach to healthcare by herbs may be very attractive to the people, but some very strong challenges are also there. Such challenges can be removed by modifying the contemporary concept and following some new formula.

I. The herbal medicines generally used in combination and their sources are variable in many cases. Species of the plant, their growing conditions, availability of biologically active constituents among them etc. are main issues.

ii. The source of herbs may be non-dependable in nature. The medicinal parts of one herb may be contaminated or adulterated with other alike looking parts of another non medicinal herb. Herbs may contain toxic compounds as a nature of the plant variety or due to the effects of soil, fertilizer, pesticides etc.

Cultivation of medicinal plants with legitimate source of supply of seeds and cultivation of them near to their natural habitat or at any alike environment can solve these two problems.

iii Like the chemical medicines, herbal medicines may have undesirable side effects to some patients, may have drug-herb interaction of herb-herb interaction.

iv. Quality of herbal medicines has impact on their efficacy and safety. Regular evaluation of the quality of herbal medicines is required for that purpose. Facility of such study is not available.

Creation of required facilities to study these two issues is necessary.

v. Organisational, national and international data base regarding composition and quality of herbal medicines is very important for their commercial cultivation, preparation of medicines and their widespread global use.

That is not available due to the reasons like lack of proper policy at national and international level and inability to think about a separate policy for herbal medicines. A positive approach can remove the problems.

vi. The present system of drug approval process involve identification and measure of quality and concentration of each component among a medicine beside other issues. But the herbal medicines are generally used as some mixtures. It is very much difficult as well as time and money consuming to identify and measure all the components present in an herbal mixture in the laboratories.

In the Allopathic system of medicine, different manufacturers of the molecule of each chemical medicine follow different systems to synthesise them. They generally keep it as a secret document. It is not uncommon to find that a single drug marketed by different manufacturers are having different level of activities. This problem is still there in case of marketed chemical medicines.

To solve the said problems of herbal medicines, analysis of main basic ingredients near the area of cultivation and then transport of them in sealed condition before mixing/ direct use by the consumers may be the option.

vii. As the raw herbs are purchased by the supplier from the market, there should be some technology to identify the quality of the materials during purchase. Such technology is not available.

Shifting of present system of purchase of raw herbs from the market to lifting of them from the field of cultivation may solve the issue.

viii. An efficient succulent herb may not be so effective at dry condition or in processed mixtures. So, the efficacy testing in all such steps are essential and such technology is not available.

ix. Determination of dose depends on the available effective or toxic phytochemicals present in the finished herbal product. Research report in that area is scarce.

x. A single effective herb contain multi-components. Some of them may be present at a negligible quantity, but may have strong influence on the efficacy of the herb. Identification and study of all such phyto-components is not possible with the present stage of knowledge in this field.

Creation of proper facility is the only solution of these three issues. It requires some new concept to create separate facilities particularly for herbal medicines. A copy-paste of the technologies applied for chemical medicines may not be effective to answer the issues related with herbal medicines [13,14].

For solving last a few questions, shifting of analysis policy from the contemporary system followed during development of synthetic medicinal drug to a separate modified system for herbal medicines may be accepted as an effective option. As the target is different in these two systems, the analysis systems should also be different.

### **Presently practiced pattern followed for chemical as well as herbal medicines:**

Diluent/ Chemical extraction/other source → active constituent isolation → safety and efficacy study → proceeding towards development of marketable medicines.

It may be shifted to a new pattern of study for herbal medicines:

Finished products/succulent bio-medicines → *in vivo* or in-patient study for validation of efficacy → dose and safety study → chemical composition analysis.

As the metabolic products of the phytoconstituents taken orally actually work inside our body system, so emphasis may be given to the effect of metabolic end products of such medicines, not on the isolated phytochemicals.

The other related research methodologies should also be different from those used for chemical medicines.

So, it can be said that cultivation of identified medicinal plants in their natural soil or near-natural soil (the soil assisted development of the wild variety of the plant), use of only bio-pesticides and fertilizers during their cultivation, regular checking of level of major phyto-chemicals in the medicinal part/s of plants before supply for their use and use of herbs as medicines with lowest modification of their natural state of availability may solve most of these problems [6,14,15].

Use of succulent bio-medicines can bi-pass most of these problems directly, apart from other positive effects. To bi-pass rest of the problems and to market such herbal products with excellent efficacies, a change in the present concept of drug development is required. As a new concept, following steps are to be followed additionally.

i) Validation of reported efficacy at succulent as well as dry conditions of the medicinal parts of herbs.

ii) Calculation of gross doses may be performed depending on the presence of the major phytochemicals at each lot/batch just after collection of raw herbs. So, depending on the presence of such phytochemicals, the quantity of each raw herb may vary from time to time during calculation of individual dose/ portion of addition in poly herbal preparations before their appearance in the finished marketable products.

iii) Performing toxicity study (individually for single succulent herb/ dry herb/ herb extract and in groups for poly-herbal preparations) at each lot/batch. [14].

### **Collection, packaging, storage and transportation of succulent bio-medicines without addition of any non-food synthetic items**

Man use succulent part of the plants as some source of many important nutrients,

micronutrients or medicines from a very ancient day. Use of dry part of the plants at required purposes were developed due to many reasons, mainly non-availability of the materials throughout the year and problem in their storage and transportation.

To bypass these problems, different synthetic chemicals are mixed with the modified succulent bio-materials before transportation. It is commonly practiced in food industry, but the packaged fruit juices or other products or the dry fruits cannot be considered as equal to the succulent fruits in at least most of the cases. On the other hand, all such added chemicals of different categories (preservatives, stabilizers, added color, added flavor and many others) are synthetic or semi-synthetic in nature. As they are not nature derived, they all are having a chance to play as some toxin inside our body system, individually, or with much more probability as some joint venture of several cumulated chemicals together [16]. Use of plastic based packaging materials and mixing of added synthetic color and additives of these plastic packaging materials with the inner products is another way of entrance of toxins inside our body, as most of such chemicals are toxic [17]. So, that cannot be considered as a safe technique in any sense.

The medicinal plant parts were also identified and used generally at the dry condition from the ancient days. The same problem of all-season availability, spoilage during storage and transportation were the main reasons behind such practices.

At the present stage of civilization, calling of such problems of storage and transportation of succulent bio-materials (from fruits to medicinal parts of plants) is not at all relevant. Techniques like packaging of the individual doses of succulent bio-medicines, paste or juice of other healthcare products etc. by capsular materials which can act as food (modified food grains, Collagen etc.) [6,18], use of preservatives like honey, different essential oils etc. of totally biological origin [6], use of cold chain techniques starting from the production of the bio-medicines up to the consumers home by following the steps like storage of the medicines at some specially designed refrigerators of different temperature ranges during transportation and storage by wholesalers and retailers before sale, use of spoilage indicator like Vaccine Vial Monitors on the outside packet etc. are already developed. These are discussed in detail in a previous publication [6].

## **Chapter IV**

### **Presence and abilities of phytochemicals in bio-medicines and the issues related with their identification**

In the contemporary systems used for validation of reported efficacy of any herb, the solvent extracted portions of the dry part of the herbs are analyzed only. It can never be said with certainty that all the phytoconstituents of even one single plant has been already identified, as it is always dependent on factors like amount of the phytochemicals present in the plant part, their solubility in the solvents or the ability of our detection systems to identify them [19].

#### **Succulent vs dry parts of plants as medicine**

Every medicinal plant contains thousands of phytochemicals. At the succulent condition, all of them get the opportunity to show their activity together. But many phytochemicals of the succulent parts of medicinal plants are definitely become absent or reduced in quantity in the dry parts due to evaporation and chemical changes of the drying procedures.

So, during the whole process, a lot of phytochemicals present in the actual plant in living condition are lost and so are not identified. But these may have some important effects on our health [14].

Among the identifiable phytochemicals of the dry plant parts, presence of alkaloids, glycosides, phenolic compounds and tannins, sapogenins, gum and mucilage, different carbohydrates, proteins and amino acids, thiosulfinates, coumarins, volatile oils and terpenoids etc. can be identified by biochemical tests in the laboratory from the solvent extracted section of the dry medicinal plant parts [20,21,22].

The phytochemicals present in the parts of medicinal plants can exert a huge number and type of effects on our health. Some of such effects are studied. The basic effects actually serve as a weapon to perform the actual effects on our health, as anti-oxidation ability of a medicinal plant part may act behind reduction of chance of cancers. Analysis of some of such important activities may help us to understand the possible anti-viral effects of these succulent bio-medicines.

### **The *Rasayana* concept of Ayurveda**

In Indian codified healthcare system, Ayurveda, one specific therapy in the name of *Rasayana* was described. The *Rasayana* therapy enhance the qualities of rasa (body fluids), enriches it with nutrients so that a person can attains qualities like longevity, freedom from health disorders, intelligence and enhanced memory power, youthfulness, optimum development of physique and sense organs etc. *Rasayana* is helpful to increase the immunity power of the person and help him to stay away from diseases [23]. *Rasayana* medicines increase resistance towards various diseases perhaps due to the properties of immunomodulation and antioxidation [24]. As per Ayurveda, *Rasayana* medicines are ‘wonder’ drugs that can be taken without any adverse effects for a long time even at healthy state [24].

During analysis, several *Rasayana* medicinal plants exhibit qualities like immunomodulation, antioxidation, anti-inflammatory, hypocholesterolaemia, antiasthmatic, hepatoprotective, antiarrhythmic, cardiogenic, antifungal, diuretic, and many other medicinal activities [25].

*Rasayana* plants have revealed a large number of compounds during phytochemical analysis which include flavonoids, carotenoids, polyphenols, curcumin, ascorbate, tocopherol etc., which are having potent immunomodulatory and antioxidant properties [25].

Many *Rasayana* plants are included in the list of this book [Table 1 and Table 2].

### **Concept of expression of collective effects of phytochemicals**

It has been argued that the contemporary methods used for study of reported effects of medicinal plants by analysis of different solvent extracted portion of dry powder of medicinal plant parts or study of the isolated phytochemicals (active principles) individually is having a very strong limitation of not giving any importance to many other phytochemicals actually present in the original plant. This is due to failure of their detection in the contemporary systems followed. But presence of even a few phytochemicals of very minute amounts (volatile, presence at undetectable amounts etc.) may have some strong effects in expression of the medicinal efficacy of the plant parts [14,15]. There may be events like suppression of toxicity of one phytochemical by another or potentiation of activity at the same manner when a plant part is used as such.

Reports of some study indicated failure in showing any activity by the active principles of some plants famous for their immunomodulatory activities in ethnomedicine [26]. On the other side, anticancer effects of green tea were identified [27].

The concept behind such debate is due to the fact that there are some basic differences between the procedures of creation and mechanism of action of chemical medicines and that of the herbal medicines. The chemical compounds generally developed singly, but even a single herb may contain some huge number of phytoconstituents, all of them always work together. So, these two systems require separate type of thinking at each step. Thus, study reports of failure of showing any activity by the isolated phytochemicals of a well-known medicinal plant part and finding anti-cancer activity of green tea may be considered as a proof of the limitation of our contemporary detection systems used to validate the claimed activities of the herbs, but it cannot certify the ethnomedicinal claims as wrong.

So, study of the reported effects of medicinal plants or their parts at the form of their actual use in the ethnomedicinal practices may be considered as the actual study of their effects. Study of the pressure extracts (juices) of succulent plants may be the best option to overcome that debate, as chemical tests on dry powders or finished polyherbal preparations may be difficult to standardize.

In many cases, the plant parts are actually used in succulent condition in ethnomedicinal practices. If required, a pre-soaking of the succulent plant parts in distilled water may assist in such pressure extraction. There are already some standard tests available to study the phytoconstituents in solvent extracts of dry medicinal plant parts [20,21,22], which may be used after some modification for validation of such pressure extracts. So, cumulative total effects of all the phytoconstituents present in the medicinal plants can be identified in that way.

## **Chapter V**

### **Study of antiviral activities of medicinal plants**

An individual can acquire immunity against a specific microorganism either

a) By natural way like getting infection/s and become immune against the invading organism/s after cure from the disease.

b) By boosting specific immunity against any particular organism or protein or any other chemical having specific nature by introduction of the weak or dead organism or protein or such chemical inside the body (as vaccination) [2].

A third way can be the modulation of immunity of individuals so that more potent protective power can resist catching of microorganisms or can reduce expression of the disease symptoms. This task can be performed by the effective medicinal plants.

The herb-based medicines may work inside the body at different ways. Though the term ‘immuno-stimulant’ is used in many literatures, but the herbal plants mainly perform the work of immunomodulation. Terms like ‘hepatoprotection’, ‘cardio-protection’ etc. or even the activities like antioxidation – all can be considered under the broad umbrella of ‘immunomodulation’. But for a better understanding of the subject in respect to the study of activities of succulent bio-medicines, it is discussed under two broad categories – immunomodulation and antioxidation.

#### **Immunomodulation by plant-derived medicines**

Modulation of the immune responses through the stimulatory or suppressive activities of the phytochemicals may help to maintain a disease-free state in normal as well as in unhealthy people [25]. Immunomodulators can enhance body’s resistance against various infections acting on the soldiers and weapons working at the base level of immune response of individuals. They may increase the oxidative activity of neutrophils and engulfment activity of phagocytic cells, may stimulate cytotoxic cells to engage more actively in their works. Disorders like viral infections, cancers, autoimmune diseases etc. may be cured for such increased activities of basic immunity of the body [28].

Immunomodulators can be classified into three broad categories: Immunoadjuvants, Immunostimulants, Immunosuppressants [29].

So, immunomodulants may inspire immune mechanism by either suppressing or stimulating one or more important sections of the immune system of the body.

1. Antigen recognition and phagocytosis:

For primary binding of antigens, phagocytosis stimulation, macrophage activation and immunostimulatory effect on peritoneal macrophages are some very important steps. Stimulation of dendritic cells, the specialised antigen presenting cells capable of directing immune responses after any infection, have tremendous effects on overall body immunity.

2. Lymphocyte proliferation and differentiation:

In this section, stimulation of lymphoid cells, modulation of T-lymphocyte function, enhancement of cellular immune function and other modulatory actions on nonspecific cellular immune systems may be included.

3. Synthesis of antibodies:

On stimulation of B lymphocytes and formation of plasma cells to synthesise antibodies of different types specific to the antigens may be influenced.

4. Antigen-antibody interaction may also be influenced.

5. Release of mediators due to immune response:

Due to modulation of cells of immune system, production of different cytokines is also influenced. The cytokines either work on receptors of cells of effector organs or on other cells of immune systems.

6. Effect on control of autoimmune diseases may be performed by modulation and correction of non-self-identity character of the cells responsible for the work.

7. Modification of target tissue response/target effector organ:

There may be increased nonspecific immunity mediators and natural killer cell numbers for such works.

8. Effects on apoptosis by controlling the programmed cell death.

9. Direct anti-viral, anti-bacterial and anti-cancer effects.

10. Initiation of other effects by acting on the Complement system of the body [5,29,30].

During the literature review, some examples of immunomodulatory activity of some isolated phytochemicals are found. Report for immunomodulatory activities of ursolic acid, glycyrrhizic acid, oleanolic acid, nomilin etc. terpenoid compounds are observed [25]. Saponins are proven to be very important phytochemicals as they may act in pharmacological activities like antiviral, immunomodulating, cytotoxic, antitumor, antiallergic, antifungal, antiphlogistic, antihepatotoxic etc. activity [25].

### **Detection of immunomodulation activity**

The contemporary methods are developed for isolation of active principle/s from any reported medicinal plant to chemically synthesize them to market as medicines. As some steps of the purpose, primarily solvent (ethanol, methanol, acetone etc.) extracted portion of the dry medicinal plant parts (generally of powdered condition) are tested for their reported efficacy. If such efficacy is found, then active principles are identified and tested. All of these tests are mainly of two types – tests involving use of different chemicals and machinery procedures excluding live animals (*in vitro* methods) and tests involving live animals (mainly laboratory animals - *in vivo* methods) [4,15].

So, several *in vitro* and *in vivo* methods are developed for pharmacological screening of solvent extracts of medicinal plant or the active principles to identify their immunomodulatory activity.

#### ***In vitro* methods:**

1. Mast cell histamine release inhibition assay
2. Study of proliferation of lymphocytes induced by mitogens
3. T cell proliferation inhibition assay
4. Macrophage chemiluminescence assay
5. *In vitro* plaque forming colony test
6. Dihydro-orotate dehydrogenase inhibition assay [4].

#### ***In vivo* methods:**

1. Study on autoimmune disease development in animals
2. Study of acute systemic anaphylaxis in rats
3. Anti-anaphylactic activity (Schultz-Dale reaction) study
4. Passive cutaneous anaphylaxis tests
5. Immediate hypersensitivity study [Arthus type]
6. Delayed type hypersensitivity study
7. Study on reversed passive Arthus reaction
8. Study of adjuvant arthritis in rats

9. Detection of Collagen type II induced arthritis in rats
10. Study of Proteoglycan-induced progressive polyarthritis in mice
11. Experimental autoimmune thyroiditis study
12. Cocksackievirus B3-induced myocarditis study
13. Porcine cardiac myosin-induced autoimmune myocarditis study in rats
14. Experimental allergic encephalomyelitis study
15. Acute graft versus host disease (GVHD) study in rats
16. Analysis of influence on SLE-like disorder in MRL/lpr mice
17. Study for prevention of experimentally induced myasthenia gravis in rats
18. Study on glomerulonephritis induced by anti-basement membrane antibody in rats
19. Auto-immune uveitis study in rats
20. Study for inhibition of allogenic transplant rejection [4].

Several authors published some very good review articles on results of *in vitro* and *in vivo* tests of either solvent extracted parts of reported immunomodulatory plants [4,31,32,33,34] or on isolated active principles of such plants [25,35,36,37]. But promising result was not found in many such studies [36].

Practically, promising results are not expected in most of the cases considering the fact that the isolated phytochemicals are almost like synthetic chemicals and so expectation of getting reported effects of mother plant part from extracted phytochemical/s is just a baseless dream in many cases. The tolerability of such isolated principles to the test animals also may not be at a good stage at high concentrations due to their nature (more like synthetic chemicals than a natural entity).

During the studies, such isolated principles are allowed to show their activities singly. In the herbal plant parts, they never get any such opportunity to work alone.

### **Anti-oxidation activity of plant medicines**

Many unprocessed and uncooked fruits and vegetables, succulent parts of many medicinal plants contain antioxidants. They assist us to fight against initiations and diseases. Expression of the genetic predisposition for many diseases is also influenced by these antioxidants.

### **Activities of antioxidants at cellular level**

During respiration, oxygen acts as the terminal electron acceptor. Oxygen splits into single atoms with unpaired electron, but these single atom oxygens seek other electrons to be in pairs. This scavenging activity of single atom oxygen, the free radicals, can cause many harms of the body.

So, formation of oxygen derived free radicals is just a consequence of aerobic metabolism. During its high reactivity, it can damage or disrupt cellular bio-molecules by producing reactive oxygen species (ROS). Different ROS (superoxide, hydrogen peroxide, hydroxyl, per hydroxyl radicals etc.) can cause damage in the DNA, proteins and lipids of the cell if its actions are not controlled by the anti-oxidants [38].

The antioxidants can either slow down or prevent oxidation of cellular molecules by removing the free radicals. So, the actual role of antioxidants is to buffer the over production of ROS and keep them in such a level that normal physiological functioning remains undisrupted. That is called redox signaling [39,40].

The free radicals show their negative activities in both maintenance of normal health as well as initiation of disease by acting in signal transduction and expression of gene of individuals. They are also involved in activation of different receptors, acting on nuclear transcription factors, influencing the cells of immune system of body for their antimicrobial activity, cytotoxic actions, ageing etc. So, oxidative stress of the cells has direct relationship with many pathophysiological states of the body [39,40].

### **Action of antioxidants**

#### **Antioxidants act against the oxidants in two ways.**

1. By direct scavenging of the free radicals produced inside the cell. In such cases, the antioxidants are called as primary antioxidants.

2. By following other ways except direct action on oxidants of the cells. A second minor component is required for such type of action. It may be binding with some metal ions, hydroperoxide conversion to non-radical species, scavenging oxygen itself, absorbing UV radiation or deactivating singlet oxygen etc. These antioxidants are termed as secondary antioxidants [39,40].

So, formation of active species, gathering of free radicals, availability of metal ions required for overactivity of oxidants etc are prohibited and repair of cellular damage caused by oxidants and stimulation of bio-synthesis of other antioxidants and defence enzymes are performed by antioxidants.

### **Measurement of antioxidation activity**

Many procedures are developed to measure the antioxidant activity of the compounds. These include Spectrophotometry, High Performance Liquid Chromatography (HPLC), Liquid Chromatography–Mass Spectrometry (LC–MS), Liquid Chromatography–Nuclear Magnetic Resonance (LC–NMR) etc. [41].

## **Free radicals and disease**

Development of disease generally involve free radicals. But generally free radicals act secondary to the initiation and progression of the disease process, but in some cases, they take the main role. Loss of balance between oxidants and antioxidants are directly attributed to at least some diseases identified through research and from analysis of epidemiological reports, but it is definitely related with healthy aging of individuals. Micronutrients play a great role in the whole process. So, it can be said that, there is a strong link between availability of micronutrients inside the cells and regulation of radox signaling and modification of gene expression to either cause or stop of the initiation and maintenance of diseases. Such micronutrients are supplied mainly through natural food [40].

Beneficial effect by supplying a large quantity of one single antioxidant is not profitable; the dilatory intake of several antioxidants (through food like succulent fruits and succulent part of effective medicinal plants) on regular basis is the only way to protect our health [39].

## **Common antioxidants of vegetable origin in dilatory source**

Many antioxidants are present in the food items and herbal plant parts. Among them, Carotenoids and Phenolic compounds are considered most important.

### **Carotenoids**

More or less 60 naturally occurring carotenoids are available in our commonly consumed fruits and vegetables [39]. Along with the pro-vitamin A carotenoids, many other carotenoids can be supplied through diet. Among them,  $\alpha$ - and  $\beta$ -carotene, and  $\beta$ -cryptoxanthin, lycopene and the hydroxy carotenoids (xanthophylls) lutein and zeaxanthin are common [39].

Almost 1000 carotenoids are identified so far, and many of them are expected to be present in the succulent parts of medicinal plants. Those may have many other important effects which are not identified so far.

### **Phenolic compounds**

This is a gathering of many families of antioxidants with some common basic structure. Among them, benzoic acid derivatives, flavonoids, pro-anthocyanidins, stilbenes, coumarins, lignans, and lignin are important. Over 400 flavonoids [36] and more than 8000 plant phenols [39] have been isolated so far. Plant phenols are antioxidants by virtue of the hydrogen-donating properties of the phenolic hydroxyl groups. The members of that category can exert their antioxidant activities by different ways, *i.e.*, scavenging free

radicals, inhibition of the enzymes like xanthine oxidase, myeloperoxidase, lipoxygenase and cyclooxygenase, interaction with other antioxidants such as ascorbate, chelation of metal ions etc. [39].

It has been found that flavonoids and other polyphenols possess activities like antitumoral, anti-allergic, anti-ischemic, and anti-inflammatory etc. [42].

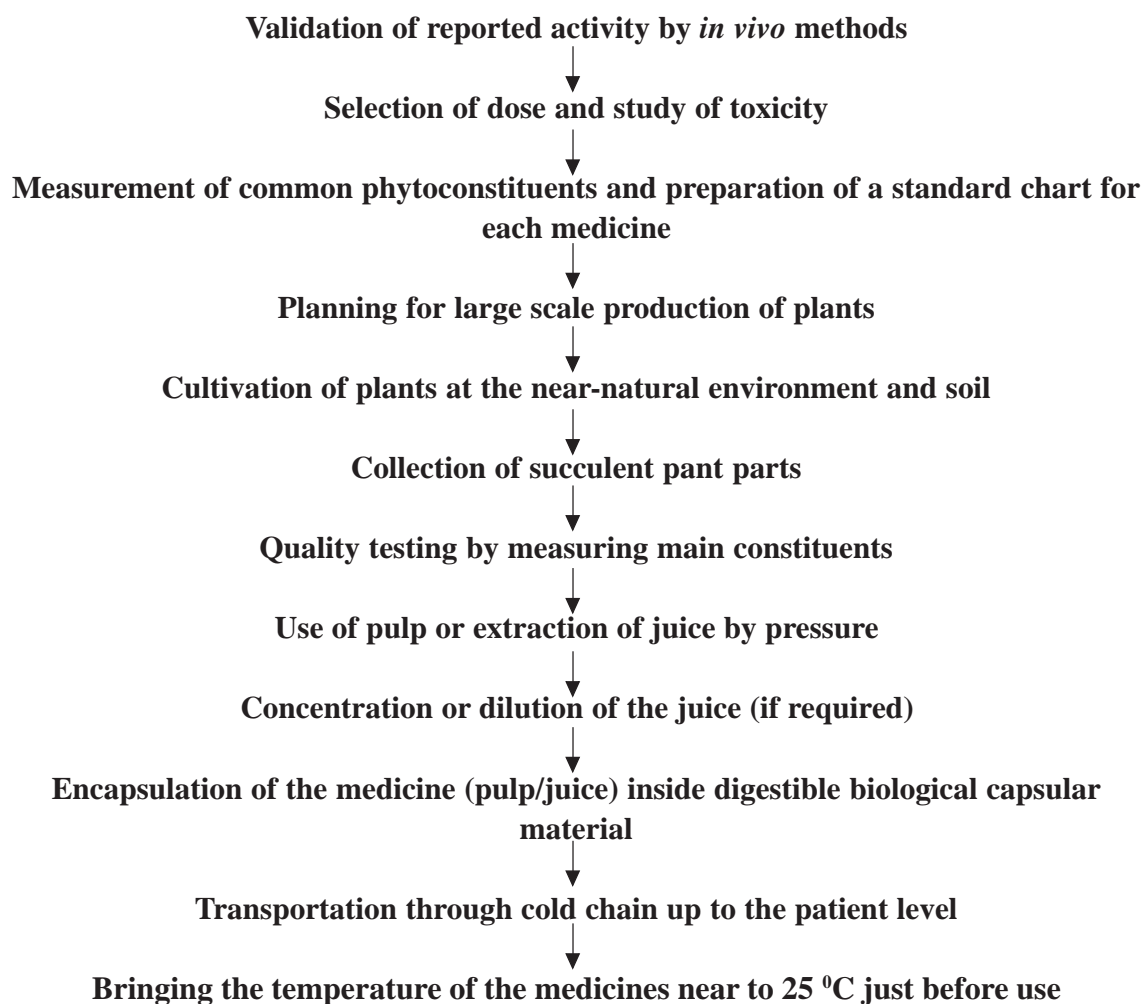
The immunomodulation and antioxidation studies are performed on solvent extracted parts or on isolated phytochemicals of the dry plant parts. As the plant parts, particularly the succulent plants contain many other phytochemicals which are not yet identified, so additional study on succulent plant parts is essential from this perspective also. The pressure extracts of the succulent plant medicines may be analyzed as such or these may be made concentrated by applying non-chemical methods like desiccation, evaporation at germ free environment with filtered air, freeze drying etc. for that purpose, if required. These may also be diluted in distilled water, ethyl alcohol etc. as per the requirements [6].

## Chapter VI

### Preparation of succulent bio-medicines to combat COVID 19

Different parameters related with production and use of succulent bio-medicines is discussed in the previous sections. The whole production and transportation system of these bio- medicines is shown is the following flow-chart.

#### Flow chart of preparation and transport of proposed succulent bio-medicines



## **Chapter VII**

### **Lifestyle and development of antiviral resistance against COVID-19**

Lifestyle plays a very important role in initiation and progression of many diseases. It has some very strong influence on expression of activities of the medicines. For the succulent bio-medicines also, maintenance of a good lifestyle will definitely assist the medicines to show their activities.

Modification of defective lifestyle a designed one may be the most important key factor for prevention and even cure of many diseases. These may have tremendous influence on overall immunity of individuals [6]. Among the important lifestyle factors, food and drink habits, staying away from the chemicals having activity like some slow poisons, maintenance of body clock by following proper working and sleeping pattern etc. are important. Generation of free radicals from intake of wrong food and drinks; intake of tobacco, narcotics, residues of pesticides, adulterated chemicals, chemical medicines etc. can either assist in disease initiation or can directly cause dangerous diseases.

Staying away from intake and use of non-natural synthetic chemicals may be the most important factor of the food-drink section. Use of cosmetics purely of natural origin [6], use of food without any added chemicals (preservatives, added color, added flavor etc.), staying away from the processed foods [16], trans fats and saturated fats [43] etc. may keep us away from reduction of our normal immunity status and triggering of our inherited genetic arrangement towards many dangerous diseases. Use of succulent bio-medicines along with following of a good lifestyle can boost non-specific individual resistance further to combat the dangerous infections like that of COVID-19. It may also be a very good option for the people to stay away from the disease and to get less stress due to the disease, if infected.

#### **The way ahead**

Stimulation of body immunity to prevent catching of viral infections like COVID - 19 by dilatory intake of a few capsule of succulent medicinal herbs prepared without addition of any synthetic material or chemical may be a very efficient alternative to the present

systems followed to prevent or treat such infections. But for this, conceptional change is required in shifting of the idea of confinement only in the presently practiced validation system of chemistry-oriented study (like isolation of active principles) to an added type of efficacy-based analysis system depending mainly on *in vivo* study for the herbal medicines. As the metabolic end products of the phytoconstituents actually work inside our body system, the contemporary study system can never be considered as a complete one. Also, a change in the concept of chemical based modern medicines and treatment system as the only effective one is a pre-requisite for development and widespread practice of that alternative system.

Ethnomedicinal use of plant parts at medicinal purposes is a very ancient practice throughout the globe. But the ethnic or rural people generally do not take or use any portion of such herbs obtained through extraction by any chemical diluent. They never use the active principles of any plant part as some medicines. But for the validation of reported efficacy, only such chemical diluent extracted part of the dry herbs or the active principles are studied worldwide. Even the name of ‘herbal medicine’ is used in the advertisement of many products (for both oral and cosmetic use) made by some synthetic chemicals and added with a few isolated phytochemicals or diluent extract/s only just to attract people to get more business from the products. The actual usable versions of the herbal ethnomedicines are never studied in the laboratory for the purposes of validation of efficacy, determination of toxicity and dose etc.

For efficient use of succulent biomedicines listed in Table 1 as well as in Table 2 to control pandemic COVID-19, searching of active principle is not a primary requirement. Rather, validation of efficacy in proper *in vivo* models or among patients and determination of dose for their early use to combat the situation is of prime importance. As almost no study has been performed in this subject scientifically, an early study is very much essential from the end of governments, entrepreneurs and research institutions. Such study does not require a large amount of investment, but having strong potentiality to open some new efficient ways to control other serious viral, bacterial, autoimmune and lifestyle diseases of the individuals along with control of the present pandemic COVID-19.

**Table 1: Medicinal plants having related reports to act against viral infections like COVID-19.**

| <b>Plant (scientific names and synonyms)</b>                                    | <b>Common name</b>   | <b>Part of plant</b> | <b>Related reported use as/in</b>  |
|---|----------------------|----------------------|--|
| <i>Adhatoda vasica</i> Nees.<br>Family: Acanthaceae                             | Malabar nut          | Leaf                 | Asthma, bronchitis, other respiratory problems, as germ killer, protective for pox infection [44,45].  |
| <i>Aegle marmelos</i> (L.)<br>Corrêa<br>Family: Rutaceae                        | Bengal quince        | Pulp of ripe fruit   | Used to cure diseases like diabetes, high cholesterol, respiratory infection. The fruit juice has anticancer, cardio protective, antibacterial, antifungal, radio protective, antipyretic, analgesic, antioxidant, antiviral, anti-inflammatory, hepatoprotective properties [46]. |
| * <i>Allium sativum</i> L.<br>Family: Amaryllidaceae                            | Single- clove Garlic | Bulb                 | Anti-inflammatory, immuno-modulation, anti-microbial as well as cardioprotective and anti-carcinogenic activity [47]; in respiratory infections, Tuberculosis, duodenal ulcer, skin problems [48].   |
| * <i>Andrographis paniculata</i> (Burm.f.) Nees.<br>Family: Acanthaceae         | King of bitters      | Leaf                 | Tonic, febrifuge, cholera, influenza, bronchitis, piles [48].  |
| * <i>Azadirachta indica</i> A. Juss.<br>Family: Meliaceae                       | Indian lilac         | Leaf                 | Plant antiseptic, in skin diseases [49]; antibacterial, antiviral, antifungal, immunomodulatory, antioxidant, anti-inflammatory etc. [50].   |
| <i>Chlorophytum borivillianum</i> Santapau & R.R. Fern.<br>Family: Asparagaceae | Musli                | Root                 | Immunomodulant, act to cure male reproductive problems [115].  |
| * <i>Citrus limon</i><br>Family: Rutaceae                                       | Lemon                | Fruit                | Anti-cancer activity, prevent kidney stones, bring down a fever, balance pH of body [51]   |
| <i>Citrus maxima</i> Merr.<br>Family: Rutaceae                                  | Pomelo               | Ripe fruit pulp      | Used in treatment of cough, fever etc. [52]. In all kinds of liver problems [48].  |

| <b>Plant (scientific names and synonyms)</b>                     | <b>Common name</b> | <b>Part of plant</b>      | <b>Related reported use as/in</b>  |
|--|--------------------|---------------------------|--|
| <i>Coriandrum sativum</i> L.<br>Family: Apiaceae                 | Coriander          | Leaf, fruit, seed, flower | Possess antioxidant activity, diuretic, anti-convulsant anti-diabetic activity, sedative hypnotic activity, anti-mutagenic, anti-microbial activity, anthelmintic activity [53]. |
| * <i>Curcuma longa</i> L.<br>Family: Zingiberaceae               | Turmeric           | Rhizome                   | Succulent rhizome as curative for pimple and many other skin diseases [14]; tonic; in sprains, bruises [48].   |
| * <i>Daucus carota</i> L.<br>Family: Apiaceae                    | Carrot             | Root                      | Immune-stimulant [14]. having antioxidant, antidiabetic, antimicrobial, smooth muscle relaxant, hypotensive etc. effects [116].  |
| * <i>Emblica officinalis</i> Gaertn.<br>Family: Phyllanthaceae   | Indian gooseberry  | Fruit                     | Immuno-stimulant during recovery from chronic diseases [14]; anti-microbial [54]; in septic fever [44].  |
| * <i>Hibiscus sabdariffa</i> L.<br>Family: Malvaceae             | Roselle            | Leaf                      | In chronic anaemia, prevention of osteoporosis, treatment for cardiac and nerve diseases [55].   |
| <i>Linum usitatissimum</i> L.<br>Family: Linaceae                | Linseed            | Seeds                     | Protection of heart and as immunostimulant [14]; can reduce bad cholesterol [56]   |
| <i>Litsea glutinosa</i> (Lour) C.B. Robins.<br>Family: Lauraceae | Indian laurel      | Leaf mucilage             | Cooling body system, as immunostimulant [14]; curing of prickly heat, summer itches and acne [57].   |
| <i>Mentha longifolia</i> (L.) Huds.<br>Family: Lamiaceae         | Mint               | Leaf                      | Treatment of colds and flu, respiratory tract problems [58]. Leaf antiseptic, stimulant, used in fever [48].   |
| * <i>Moringa oleifera</i> Lam.<br>Family: Moringaceae            | Drumstick tree     | Old leaf, flower          | Leaf in high blood pressure, flower as immunostimulant, root as antimicrobial preservative [44]; seed and leaf in leprosy [59].  |

| <b>Plant (scientific names and synonyms)</b>           | <b>Common name</b> | <b>Part of plant</b> | <b>Related reported use as/in</b>  |
|--|--------------------|----------------------|--|
| <i>*Nigella sativa</i> L.<br>Family: Ranunculaceae     | Black cumin        | Seed                 | In asthma, bronchitis, high blood pressure, inflammation, rheumatoid arthritis, immune-boosting and antioxidant benefits [60].   |
| <i>*Ocimum sanctum</i> L.<br>Family: Lamiaceae         | Holy Basil         | Leaf                 | Expectorant and as immunostimulant [14]; in bronchitis, skin infections [48].  |
| <i>*Pimenta dioica</i> (L.) Merr.<br>Family: Myrtaceae | Allspice           | Berries              | Antioxidant, anticancer, antibacterial, hypotensive, anti-neuralgic and analgesic properties [61].   |
| <i>Piper betel</i> L.<br>Family: Piperaceae            | Betel              | Leaf                 | Anti-diabetic, cardiovascular protector, anti-inflammatory, immune-modulatory, anti-ulcer, hepato-protective, anti-infective, anti-cancer effects [62].  |
| <i>Piper longum</i> L.<br>Family: Piperaceae           | Long pepper        | Fruit                | Roots and fruits in diseases of respiratory tract [48]; plant antiseptic [49]  |
| <i>Piper nigrum</i> L.<br>Family: Piperaceae           | Black pepper       | Berries              | Cough, sinusitis, gonorrhoea [44]; antimicrobial [49]  |
| <i>Tamarindus indica</i> L.<br>Family: Fabaceae        | Tamarind           | Leaf, fruit          | Leaf in common cold, chronic amoebiasis; boiled leaf in old wound, stomatitis; fruit protective to arteriosclerosis, seed antiaging [44]; stored fruit pulp in liver ailments [63]; leaf and stem bark antimicrobial [64]; laxative, abdominal pain, diarrhoea, dysentery, peptic ulcer, spasmolytic, cancer, antimicrobial, antiparasitic, antifungal, antiviral, anti-inflammatory, antioxidant, anti-diabetic, wound healing agent [65] |

| <b>Plant (scientific names and synonyms)</b>                                | <b>Common name</b>          | <b>Part of plant</b> | <b>Related reported use as/in</b>  |
|---|-----------------------------|----------------------|--|
| <i>*Taraxacum officinale</i> (L.) Weber ex F.H. Wigg.<br>Family: Asteraceae | Dandelion                   | Root, whole plant    | As immuno-stimulant for treatment and prevention of various diseases like diabetes [66], spleen and liver problems, cancer etc. [67]; it has diuretic, choleric, anti-inflammatory, anti-oxidative, anti-carcinogenic, analgesic, anti-hyperglycemic, anti-coagulatory and prebiotic effects [67]. |
| <i>*Terminalia chebula</i> Retz.<br>Family: Combretaceae                    | Black myrobalan             | Dry fruit            | Overall immunostimulant, in kidney and liver problems [68]; fruit in chronic ulcers, wounds, scalds [49]. It has antitussive, cardiogenic, homeostatic, diuretic and laxative effects [68].  |
| <i>*Thymus vulgaris</i> L.<br>Family: Lamiaceae                             | Common thyme                | Leaf                 | In cough and bronchitis; sore throat, urinary antiseptic [69].   |
| <i>*Tinospora cordifolia</i> (Thunb.) Miers.<br>Family: Menispermaceae      | Indian Tinospora            | Stem                 | Immunostimulant, used in chronic diseases [70]; febrifuge, analgesic, urinary diseases, jaundice, rheumatism, leprosy [48].  |
| <i>*Vaccinium corymbosum</i> L.<br>Family: Ericaceae                        | Northern highbush blueberry | Fruit                | Used for prevention of cancers and heart diseases; treatment of urinary tract infections and depression [71].  |
| <i>*Withania somnifera</i> (L.) Dunal.<br>Family: Solanaceae                | Indian ginseng              | Root                 | Root in cough, rheumatism, ulcers [48]. antioxidant, anti-inflammatory, and immunomodulatory [72].   |
| <i>*Zingiber officinale</i> Roscoe.<br>Family: Zingiberaceae                | Ginger                      | Rhizome              | Antioxidant, stimulant [48]. in pharyngitis, common cold; considered immunostimulant [14].   |

\*May be given preference.

**Table 2: Additional medicinal plants having related reports to act against viral infections like COVID-19.**

| <b>Plant (scientific names and synonyms)</b>                      | <b>Common name</b>  | <b>Part of plant</b>   | <b>Related reported use as/in</b>  |
|---|---------------------|------------------------|--|
| <i>Abutilon indicum</i> (Link) Sweet.<br>Family: Malvaceae        | Indian mallow       | Whole plant            | Various parts of the plant are used as a demulcent, aphrodisiac, laxative, diuretic, sedative, astringent, expectorant, tonic, anti-inflammatory, anthelmintic, and analgesic and to treat leprosy, ulcers, headaches, gonorrhea, and bladder infection [73,74]. |
| <i>Acacia leucophloea</i> (Roxb.) Willd.<br>Family: Fabaceae      | White barked Acacia | Bark extract           | Preventive and curative of microbial infections [54,75].   |
| <i>Acalypha indica</i> L.<br>Family: Euphorbiaceae                | Indian Acalypha     | Root                   | Lung problems like asthma, pneumonia, antibacterial and antifungal activities, both against human and plant pathogens [76].  |
| <i>Acanthospermum hispidum</i> (DC) A Chev.<br>Family: Asteraceae | Bristly Starbur     | Juice/oil of the plant | As immune-stimulant against infections (anti-bacterial antifungal, anti-parasitic) [77]; oil antibacterial, antifungal [48].   |
| <i>Aframomum melegueta</i> K. Schum.<br>Family: Zingiberaceae     | Grains of paradise  | Seed                   | Protection from infectious diseases [78], as well as from inflammation and heart diseases [79]   |
| <i>Angelica sinensis</i> (Oliv.) Diels<br>Family: Apiaceae        | Female ginseng      | Root                   | Tonic, hematopoietic and anti-inflammatory [80]  |
| <i>Asparagus racemosus</i> Willd.<br>Family: Asparagaceae         | Satavari            | Root                   | Immune stimulant, antioxidant, anti-dyspepsia, anti-tussive; in kidney disorders, chronic fevers, liver cancer, stomach ulcers etc. [81].  |
| <i>Astragalus propinquus</i> Schischkin<br>Family Fabaceae        | Astragalus          | Root                   | In general debility, chronic illnesses, increase the overall vitality of the system, immune stimulating, in treating immune deficiency conditions,   |

| Plant (scientific names and synonyms)                            | Common name           | Part of plant            | Related reported use as/in  |
|--|-----------------------|--------------------------|---|
|  |                       |                          | immunopotential effects, adjunct cancer therapy [82].   |
| <i>Atractylodes lancea</i> Thunb.<br>Family: Asteraceae          | Atractylodes          | Rhizome                  | Common cold, influenza, rheumatic diseases [83]   |
| <i>Bacopa monnieri</i> (L.) Pennell.<br>Family: Scrophulariaceae | Thyme-leaved gratiola | Leaf and stem            | Plant antimicrobial [54]; for memory boosting, and the treatment of cardiac, respiratory and neuropharmacological disorders [84].                                       |
| <i>Boerhavia diffusa</i> L.<br>Family: Nyctaginaceae             | Spreading hogweed     | Root                     | Root expectorant, diuretic, asthma [48]; disorders of respiratory system, reproductive system, urinary system, hepatic system, cardiovascular system, cancer etc. [85]. |
| <i>Bupleurum chinense</i> DC.<br>Family: Apiaceae                | Hare's ear Root       | ear root                 | To cure infectious diseases, inflammatory disorders [86].   |
| <i>Camellia sinensis</i> (L.) Kuntze<br>Family: Theaceae         | Tea plant             | Leaf                     | Anti-oxidant, anticancer, cardioprotective, boosting of immunity, anti-diabetic [87].   |
| <i>Catharanthus roseus</i> (L.) G.Don.<br>Family: Apocynaceae    | Cayenne jasmine       | Leaf and stem            | antitumor, anti-diabetic, anti-microbial, anti-oxidant and anti-mutagenic effects [88].   |
| <i>Centella asiatica</i> (L.) Urb.<br>Family: Apiaceae           | Indian Pennywort      | Leaf                     | Leaf extract to children for immunostimulation [14].  |
| <i>Cinnamomum verum</i> J.Presl.<br>Family: Lauraceae            | Cinnamon              | Dried inner part of bark | Given to patients of cold and flu [89].   |

| <b>Plant (scientific names and synonyms)</b>                    | <b>Common name</b>  | <b>Part of plant</b> | <b>Related reported use as/in</b>   |
|---|---------------------|----------------------|---|
| <i>Convolvulus prostratus</i> Frossk.<br>Family: Convolvulaceae | Shankhapushpi       | Various parts        | Memory enhancer, antioxidant, antimicrobial, antidiabetic, antiulcer, hypolipidemic, antipyretic, analgesic, anti-inflammatory, hypotensive, anxiolytic, tranquilizing, diuretic, insecticidal properties [90]. |
| <i>Coptis chinensis</i> Franch.<br>Family: Ranunculaceae        | Chinese goldthread  | Rhizome              | Having neuroprotective, neuro-regenerative, anti-diabetic, anti-oxidative and anti-inflammatory effects [91].   |
| <i>Costus igneus</i> N.E. Br.<br>Family: Costaceae              | Fiery costus        | Leaf                 | Leaf as hypoglycemic, hypolipidemic, antioxidant, antiproliferative, anti-inflammatory [92].  |
| <i>Ephedra sinica</i> Stapf.<br>Family: Ephedraceae             | Chinese ephedra     | Stem                 | Used to treat cold, bronchial asthma, cough, fever, flu, headache, edema and allergies [93]   |
| <i>Eutrema japonicum</i> (Miq.) Koidz.<br>Family: Brassicaceae  | Wasabi              | Rhizome              | Antibacterial, anti-cancer and anti-inflammatory effects; can slow blood clotting and stimulate bone growth [94].   |
| <i>Glycyrrhiza glabra</i> L.<br>Family: Fabaceae                | Liquorice           | Rhizomes and roots   | Tonic, catarrhal affections, urinary problems [48]; antiseptic [49]   |
| <i>Gmelina arborea</i> Roxb.<br>Family: Lamiaceae               | Beechwood           | Bark                 | Stomachic, galactagogue, laxative. anthelmintic, improve appetite, useful in hallucination, piles, abdominal pains, burning sensations, fever etc. [95]   |
| <i>Hemidesmus indicus</i> (L.) R.Br.<br>Family: Apocynaceae     | Indian sarsaparilla | Root                 | Anti-cancerous, immuno-modulator, anti-diarrheal, antioxidant, anti-leprotic, diuretic etc. [96]  |
| <i>Ipomoea reptans</i> (L.) Poir<br>Family: Convolvulaceae      | Water Spinach       | Leaf and soft stem   | Leaf for protection from chicken pox, gonorrhoea [44]; immunostimulant in herbivores [14].  |

| <b>Plant (scientific names and synonyms)</b>           | <b>Common name</b>      | <b>Part of plant</b> | <b>Related reported use as/in</b>   |
|--|-------------------------|----------------------|---|
| <i>Laurus nobilis</i> L.<br>Family: Lauraceae          | Bay laurel              | Leaf                 | Diuretic, anti-inflammatory, cardioprotective, prevent cancers, reduce stress [97]  |
| <i>Ligusticum striatum</i> DC.<br>Family: Apiaceae     | Szechuan lovage         | Root                 | Enhancement of the immune system, treatment of ischemic disorders, as an anti-inflammatory agent [82].  |
| <i>Lycium barbarum</i> L.<br>Family: Solanaceae        | Wolfberry               | Fruit                | Anti-aging, to treat blurry vision, abdominal pain, infertility, dry cough, fatigue, dizziness, and headache [98]   |
| <i>Nyctanthes arbor-tristis</i> L.<br>Family: Oleaceae | Night-flowering jasmine | Leaf                 | Having hepatoprotective, anti-leishmaniasis, antiviral, antifungal, antipyretic, antihistaminic, antimalarial, antibacterial, anti-inflammatory, antioxidant activities [99].               |
| <i>Origanum vulgare</i> L.<br>Family: Lamiaceae        | Wild marjoram           | Leaf, oil            | In respiratory tract disorders, urinary tract disorders, can act against cancers, as antioxidant and in diabetes [100].   |
| <i>Origanum majorana</i> L.<br>Family: Lamiaceae       | Marjoram                | Leaf                 | Remedy for chest infection, cough, sore throat, rheumatic pain, nervous disorders, cardiovascular diseases, epilepsy, insomnia etc [101], potent antioxidant [102]                          |
| <i>Paeonia lactiflora</i> Pall.<br>Family: Paeoniaceae | Chinese peony           | Root                 | Antispasmodic, diuretic, sedative and tonic; treatment of convulsions and spasmodic nervous affections, whooping cough [103]  |
| <i>Panax ginseng</i> C.A. Meyer<br>Family: Araliaceae  | Asian ginseng           | Root                 | It has varied actions and effects on the body that support nonspecific resistance to biochemical and physical stressors, improve vitality and longevity, and enhance mental capacity [104]. |

| <b>Plant (scientific names and synonyms)</b>                         | <b>Common name</b>                | <b>Part of plant</b> | <b>Related reported use as/in</b>  |
|--|-----------------------------------|----------------------|--|
| <i>Picrorhiza kurroa</i> Royle ex Benth.<br>Family: Plantaginaceae   | Katuki                            | Rhizome              | In asthma, jaundice, fever, malaria, snake bite and liver disorders. Having anti-microbial, anti-oxidant, anti-bacterial, anti-mutagenic, cardio-protective, hepato-protective, anti-malarial, anti-diabetic, anti-inflammatory, anti-cancer, anti-ulcer and nephro-protective activities [105]. |
| <i>Randia dumetorum</i> Poir.<br>Family: Rubiaceae                   | Emetic nut                        | Various parts        | To treat cough, skin diseases, ulcers, asthma, flatulence, colic etc. [106].   |
| <i>Rehmannia glutinosa</i> (Gaertn.) Steud.<br>Family: Orobanchaceae | Rehmannia                         | Root                 | Possess wide pharmacological actions on the blood system, immune system, endocrine system, cardiovascular system and the nervous system [107]  |
| <i>Rheum emodi</i> Wall. ex Meisn.<br>Family: Polygonaceae           | Himalayan rhubarb, Indian rhubarb | Roots and rhizomes   | Immune-stimulant during disease condition and after recovery; to treat fever, cough [114]; it possesses anticancer, antioxidant, anti-inflammatory, antimicrobial, antifungal, anti-diabetic, antiulcer, hepato-protective, immune-enhancing and nephroprotective activities [108].              |
| <i>Rosmarinus officinalis</i> L.<br>Family: Lamiaceae                | Rosemary                          | Leaf                 | Boosting immunity power and improve memory power; to alleviate muscle pain, improve memory, boost the circulatory system, and promote hair growth [109].   |
| <i>Salvia officinalis</i> L.<br>Family: Lamiaceae                    | Common sage                       | Leaf                 | Immunomodulation, increase efficacy of different body systems and increase in memory power [110].  |
| <i>Saussurea costus</i> (Falc.) Lipsch.<br>Family: Asteraceae        | Costus                            | Root                 | Root tonic, in asthma, cough, rheumatism, chronic skin diseases [48].  |

| <b>Plant (scientific names and synonyms)</b>   | <b>Common name</b> | <b>Part of plant</b> | <b>Related reported use as/in</b>   |
|--|--------------------|----------------------|---|
| <i>Schisandra chinensis</i> (Turcz.) Baill.<br>Family: Schisandraceae                | Magnolia-vine      | Berries              | Increase resistance to stresses, has hepato-protective abilities, act as potent antioxidant [82].   |
| <i>Smilax ornate</i> Lem.<br>Family: Smilacaceae                                     | Sarsaparilla       | Root                 | Strengthening of liver, kidney, disease prevention power of skin and overall body immunity; also used along with conventional drugs for treating leprosy and for syphilis [111].                |
| <i>Sphaeranthus indicus</i> L.<br>Family: Asteraceae                                 | Thistle            | Various parts        | Tonic, hepatic and gastric disorders, chest troubles, tuberculosis [48]   |
| <i>Syngium Cumini</i> (L) Skells.<br>Family: Myrtaceae                               | Black plum         | Bark                 | Used in sore throat, bronchitis, asthma, ulcer [49]   |
| <i>Syzygium aromaticum</i> (L.) Merrill & Perry.<br>Family: Myrtaceae                | Clove              | Bud                  | Anticancer, antidiabetic anti-inflammatory, antinociceptive, antibacterial, antifungal, antiprotozoal, antioxidant, and antithrombotic properties, as well as other biological activities [112] |
| <i>Swertia chirayita</i> (Roxb.) Buch. -Ham. ex C.B. Clarke.<br>Family: Gentianaceae | Chirayata          | Leaf                 | As anti-pyretic, anti-periodic, anti-inflammatory, in diabetes [113]; in asthma, liver diseases, internal hemorrhage of stomach [48]; in chronic diseases [14].                                 |
| <i>Trachyspermum ammi</i> (L) Sprague.<br>Family: Apiaceae                           | Bishop's weed      | Fruit                | Tonic; in bronchitis, cholera, sore throat; root diuretic, febrifuge, stomach disorder; oil antiseptic, respiratory ailments [48].  |

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Dr. Shibabrata Pattanayak, B.A.Sc. & A.H.; M.V.Sc. (Immunology); P.G.D.R.D.; F.M.D.I.T.; Ph. D. (Pharmacology) is working for development of one alternative healthcare system excluding intake of any synthetic chemical and following of a designed lifestyle along with use of unaltered herbs directly as medicine.

Succulent parts of some effective medicinal plants with strong immunomodulation activities can be used to prevent catching of the virus by the individuals as well as for reduction of severity of symptoms of the patients of COVID-19. The paste or pressure extracts of the succulent plant parts can be covered by some digestible capsular materials of biological origin and can be transported to every corner of the globe. Identification of the plant parts; layout for production, transportation and use of the succulent bio-medicines are included and different related parameters are discussed in this book.

Works of Dr. Pattanayak grabbed the attention of the related researchers throughout the globe. Dr. Pattanayak presently ranked above 97% of the global researchers enlisted under Research Gate as per their calculation of Total Research Interest.

This book is offered to the researchers, entrepreneurs, policy makers and all conscious persons with a request to play their role for early availability of these bio-medicines in the market to combat the present situation made by COVID-19 and also to stay away from the disease.